

Applicant : Martin Willard et al.
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Amendments to the Claims:

This listing of claims replaces all prior versions and listings of claims in the application:

Listing of Claims:

1. (Currently Amended) A method of cooling a target tissue region inside a body, the method comprising:

providing non-oxygenated fluid cooled below normal body temperature and oxygenated blood at a normal body temperature to the tissue region in proportions to cool the tissue region and maintain, for an extended period of time greater than two minutes, the temperature of the tissue region within a target temperature range that is one to nine degrees Celsius below normal body temperature, wherein the oxygenated blood is provided so that any continuous period of time during which the tissue region is deprived of oxygenated blood while the non-oxygenated fluid is being provided continues for less than two minutes.

2. (Original) The method of claim 1 wherein the cooled fluid and the blood at normal body temperature are provided to the tissue region simultaneously.

3. (Original) The method of claim 1 wherein the providing of the blood at normal body temperature to the tissue region is performed using a catheter that occludes a vessel upstream from the tissue region and permits a selected amount of blood to flow through a lumen in the catheter and to the tissue region.

4. (Original) The method of claim 3 wherein the catheter also performs the providing of cool fluid to the tissue region.

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5. (Original) The method of claim 1 wherein the providing of blood to the tissue region is performed by occluding a vessel upstream from the tissue region to restrict normal blood flow and then removing the occlusion to permit normal blood flow.

6. (Original) The method of claim 1 wherein a catheter provides blood to the tissue region by partially occluding a vessel in fluid communication with the tissue region to permit a restricted amount of blood to flow to the tissue region.

7. (Original) The method of claim 1 wherein a catheter positioned in a vessel in fluid communication with the tissue region provides the fluid to the tissue region through a lumen that extends longitudinally through the catheter, the lumen having a diameter of at least twenty thousandths of an inch.

8. (Original) The method of claim 1 wherein the temperature of the tissue region is maintained within the target temperature range that is below normal body temperature for a time period beyond the normal length of time a tissue region is deprived of oxygenated blood during a heart procedure.

9. (Original) The method of claim 8 wherein the normal length of time a tissue region is deprived of oxygenated blood during a heart procedure is about two minutes.

10. (Original) The method of claim 1 wherein the temperature of the tissue region is maintained within the target temperature range for at least about two minutes.

11. (Original) The method of claim 1 wherein the temperature of the tissue region is maintained within a target temperature range of about 28 to 36 degrees Celsius.

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12. (Original) The method of claim 1 wherein the providing of fluid and blood to cool the target tissue region is performed during a procedure to open a lesion in a vessel.

13. (Original) The method of claim 1 wherein a control system controls the providing of fluid and blood to the tissue region.

14. (Original) A method of cooling a target tissue region inside a body, the method comprising:

occluding a body vessel to prevent normal blood flow to the tissue region;

providing, while the body vessel is occluded, cooled fluid to the tissue region to cool the tissue region below normal body temperature;

recommencing normal blood flow to the tissue region by removing the occlusion in the body vessel;

preventing normal blood flow to the tissue region again by occluding the body vessel before the temperature of the tissue region returns to normal body temperature; and

providing, while the body vessel is occluded, cooled fluid to the tissue region again to maintain the temperature of the tissue region below normal body temperature.

15. (Original) The method of claim 14 wherein the body vessel is occluded to prevent normal blood flow to the tissue region by inflating a balloon positioned in the vessel.

16. (Original) The method of claim 14 wherein a catheter positioned in a vessel at a location upstream from the tissue region provides the fluid to the tissue region through a lumen extending longitudinally through the catheter, the lumen having a diameter of at least twenty thousandths of an inch.

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17. (Original) The method of claim 14 wherein a control system controls the occluding of the body vessel and the providing of cooled fluid to the tissue region to maintain the temperature of the tissue region below normal body temperature.

18. (Currently Amended) A method of cooling a target tissue region inside a body, the method comprising:

restricting normal blood flow to the tissue region so that only a desired amount of blood is provided to the tissue region; and

providing cool fluid to mix with the blood provided to the tissue region so as to cool the tissue region below normal body temperature and to maintain, for an extended period of time greater than two minutes, the temperature of the tissue region within a target temperature range that is one to nine degrees Celsius below normal body temperature.

19. (Original) The method of claim 18 wherein the providing of the blood at normal body temperature to the tissue region is performed using a catheter that occludes a vessel upstream from the tissue region and permits a selected amount of blood to flow through a lumen in the catheter and to the tissue region.

20. (Original) The method of claim 18 wherein the providing of blood at normal body temperature to the tissue region is performed using a catheter to partially occlude a vessel upstream from the tissue region and permit a selected amount of blood to reach the tissue region.

21. (Original) The method of claim 18 wherein the temperature of the tissue region is maintained within the target temperature range that is below normal body temperature for a time period beyond the normal length of time a tissue region is deprived of oxygenated blood during a heart procedure.

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22. (Original) The method of claim 21 wherein the normal length of time a tissue region is deprived of oxygenated blood during a heart procedure is about two minutes.

23. (Original) The method of claim 18 wherein the temperature of the tissue region is maintained within the target temperature range for at least about two minutes.

24. (Original) The method of claim 18 wherein a catheter positioned in a vessel in fluid communication with the tissue region provides the fluid to the tissue region through a lumen that extends longitudinally through the catheter, the lumen having a diameter of at least twenty thousandths of an inch.

25. (Original) The method of claim 18 wherein a control system controls the providing of fluid to the tissue region to maintain the temperature of the tissue region below normal body temperature.

26. (Withdrawn) A system for controlling the temperature of a target tissue region inside the body, the system comprising:

a catheter for providing cooled fluid to the tissue region and for controlling normal blood flow to the tissue region; and

a control system that controls the amount of the cooled fluid and blood that the catheter provides to the tissue region so as to cool and to maintain, for an extended period of time, the tissue region within a target temperature range that is below normal body temperature.

27. (Withdrawn) The system of claim 26 wherein the catheter for providing fluid and controlling normal blood flow to the tissue region is a perfusion catheter.

28. (Withdrawn) The system of claim 26 wherein the catheter for providing fluid and controlling normal blood flow to the tissue region is a balloon catheter.

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29. (Withdrawn) The system of claim 26 wherein the catheter comprises an infusion lumen for providing fluid to the tissue region, the infusion lumen having a diameter of at least twenty thousandths of an inch.

30. (Withdrawn) The system of claim 26 wherein the control system comprises a controller that controls the cooling of the tissue region without measuring the temperature of the tissue region.

31. (Withdrawn) The system of claim 26 wherein the control system comprises a controller that controls the cooling of the tissue region without measuring the temperature of the cool fluid as it exits the catheter and is provided to the tissue region.

32. (Withdrawn) The system of claim 26 wherein the catheter includes a temperature sensor that may be advanced to a location distal to the catheter to measure the temperature of the tissue region.

33. (Withdrawn) The system of claim 32 wherein the control system comprises a temperature monitor that receives temperature information from the temperature sensor.

34. (Withdrawn) The system of claim 26 wherein the control system comprises an infusion pump to control the amount of cool fluid provided to the tissue region.

35. (Withdrawn) The system of claim 26 wherein the control system comprises an inflation pump to inflate and deflate a balloon on the catheter, the balloon controlling the amount of blood provided to the tissue region.

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36. (Withdrawn) A catheter for providing cool fluid to a tissue region inside a body, the catheter comprising:

an elongated member having a lumen extending longitudinally therethrough to a distal end of the elongated member; and

a temperature sensor that extends to a location distal to the distal end of the elongated member to sense the temperature of the tissue region.

37. (Withdrawn) The catheter of claim 36 wherein the temperature sensor is a thermocouple.

38. (Withdrawn) The catheter of claim 37 wherein the thermocouple comprises two conductors of different material extending from a proximal end of the catheter and joined at a distal end to form a junction.

39. (Withdrawn) The catheter of claim 36 wherein the temperature sensor senses the temperature of the tissue region by measuring the temperature of a vessel wall located distal to the distal end of the elongated member and adjacent to the target tissue region.

40. (Withdrawn) The catheter of claim 36 wherein the temperature sensor senses the temperature of the tissue region by measuring the temperature of the cool fluid provided to the tissue region distal to the distal end of the elongated member and adjacent to the target tissue region.